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A Strategic and Industrial Assessment of Sea Mine Warfare in the Post-Cold War Era

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Department of the Navy

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ABSTRACT

A Strategic and Industrial Assessment of Sea Mine Warfare in the Post-Cold War Era

By Dr. Raymond S. Widmayer

The purpose of my paper is to provide a strategic-level assessment of sea mine warfare in the post-Cold War era by addressing both government and industrial points of view. I review and summarize U.S. national security and military strategies vis-a-vis mine warfare, and I emphasize the basic roles mine warfare has the potential of playing in implementation of these strategies.

The strategic role of mine countermeasures in future regional crises and contingencies is clear cut, having been unquestionably demonstrated during Desert Storm. However, the role of mining is far less defined, but, as I substantiate in my paper, is also of significant strategic importance in the future. I recommend maintaining and preferably expanding the mine countermeasures program being supported by the Navy, and I recommend initiating a program to tune our mine inventory to the post-Cold War era threat.

From the industrial perspective, I offer the significantly expanding mine countermeasures program as a very attractive industrial incentive. In addition, I provide several recommendations for both industry and government to help enhance the role industry can play in mine warfare in the future.

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The majority of the research conducted for this paper did not consist of library and literature reviews, but rather was based upon oral and written contributions provided by senior members of the mine warfare communities of the United States and its allies. Early in the research paper process, I sent a letter to some forty senior mine warfare colleagues, explaining the topic of my paper and requesting comments and suggestions as appropriate. To my great satisfaction, I received very timely and insightful responses from nearly all of these mine warfare experts. Therefore, I would like to take this opportunity to express my sincere appreciation for the invaluable help that these professionals provided to me...help without which I could not have written the paper. Hopefully the words that I have written will in some small way assist in enhancing mine warfare activity both in the United States and among our allies, and therefore, will also serve to help repay these gentlemen for their excellent contributions.

I would also like to express my sincere appreciation to Captain D'Arcy Roper, USN, who served as my ICAF faculty advisor for this paper. His knowledgeable guidance and strategic point of view have helped me significantly in paper preparation and review.

Ray Widmayer, ICAF '93

INTRODUCTION

"We have lost control of the seas to a nation without a navy, using pre-World War I weapons, laid by vessels that were utilized at the time of the birth of Christ."

This comment gets your attention, doesn't it?

It was the response of RADM Allan Smith, commander of the United Nations amphibious task force at Wonsan, North Korea, reporting to his superior about a one-week additional delay in the October 1950 Wonsan amphibious invasion...a delay that resulted from North Korean use of sea mines [1]. The North Korean action of laying relatively crude, but effective mines as a defense against the amphibious invasion at Wonsan resulted in a major setback of one of the key UN military offensives of the War. In fact, throughout history, dating from at least the Civil War up to and certainly including Desert Storm, the ubiquitous sea mine has proven to be a pivotal, lethal, affordable, insidious, yet somewhat unappreciated and always unglamorous weapon. For example:

- o mines are the "torpedoes" that RADM Farragut damned in 1864 in the Civil War battle of Mobile Bay.[2],

- o mines are the weapons that virtually blockaded the North Sea to German U-boat transits in World War I,

- o mines are the weapons that sank or severely damaged some 3000 Axis and Japanese ships in World War II, and are the weapons that virtually strangled Japan in the closing months of that war,

offering the non-selected option of not using nuclear weapons to end the war with Japan [3],

- o mines are the weapons that helped bring North Vietnam to the negotiating table through the blockade of Haiphong Harbor, and

- o mines are the weapons that have caused the most significant war damage to U.S. naval ships since Wonsan! (USS Samuel B. Roberts (FFG-58), USS Princeton (CG-59), and USS Tripoli (LPH-10)).

In short, mines are formidable weapons...weapons that make the complementary area of mine countermeasures an unusually difficult challenge!

The warfare area designated as mine warfare...the combination of both mining and mine countermeasures...is an area that normally is low in visibility and low in funding, but has been spurred over the years by occasional short lived bursts of enthusiasm, depending on what's in the headlines. I believe, however, the time has arrived for aggressive mine warfare action over the long haul. Two major events lead to this conclusion. First, among the key lessons learned from Desert Storm was a renewed appreciation of the potential of mines and an alarming awareness of the complexity and inadequacies of mine countermeasures, especially in shallow, amphibious operating areas [4]. Second, the unprecedented change in the world's political structure leading to the post-Cold War era has emphasized limited regional contingencies rather than global conventional war. As will be demonstrated later in this paper, the combination of these two situations leads to the strategic advantages of mining and the necessity for effective, considerably

improved mine countermeasures in the future U. S. defense posture. An assessment of mine warfare is clearly warranted to help formulate an outyear mine warfare program structure that is fully commensurate with new regional strategies and with political and fiscal constraints. In addition, the influence of mine warfare upon industry, and vice-a-versa, must be factored into the picture to fully place mine warfare into the new perspective.

As a final introductory point, I would like to define my use of the term "strategy" for the purposes of this paper. In this regard I'll identify three levels of U.S. political-military interactions, namely policy, strategy, and tactics. Policy is the overall national goals and long term thrusts of the U.S. An example would be maintenance of sea lines of communication world wide to assure our ability to respond to regional crises. Strategy is the macro-level approach to achieving the policy goals. An example would be the use of military blockades of sea lines of communication of a belligerent country to effect a solution to an adverse situation with minimum casualties on both sides. Finally, tactics is the operational level of implementation of a strategy. An example would be the use of a combination of mines, surface ships, and aircraft to achieve a naval blockade. Thus, "strategy" for my purposes in this paper is the mid-level of political-military activity pertaining to implementing overall policy but not concerned with the actual force deployment operational structure. I am therefore not particularly concerned in this paper with the adequacy of individual mine warfare systems or equipment, nor will

I dwell on detailed mine warfare programmatics. Rather, I will assess mine warfare in the post-Cold War era as a means...or strategy...of supporting overall U.S. policy.

MINE WARFARE OVERVIEW AND HISTORICAL SKETCH

Sea mine warfare is the warfare area concerned with the development, acquisition, operational deployment, and countering of sea mines. Sea mines date to the American Revolutionary War when Bushnell's keg became the first operational sea mine. This device was actually a large keg of explosive suspended from a float. The contraption was initiated by a crude flintlock impact fuze which detonated upon contact with a ship (or at least that was the general idea). Although no real damage was sustained by the British during what was called the "Battle of the Kegs" in late 1777, this event did represent the first operational use of sea mines [5]. Mine design progressed from that point to the early 1900's with the development of the classical spherical moored mine with protruding, ominous horns awaiting contact with an unsuspecting ship target. Again, crude, but, unlike Bushnell's keg, very effective. It is interesting to note that some of the mines recently causing damage to U.S. warships and other vessels in the Persian Gulf were exactly this vintage of mine (pre-World War I Russian-design moored contact mines). Modern mines are typically influence mines requiring a combination of ship magnetic, acoustic, and pressure signatures to detonate. These mines can be either moored or located on the bottom and normally have TNT

equivalent explosive weights from 500 to 2000 lbs. One mine, the U.S. CAPTOR mine, houses a torpedo. Upon target acquisition, the torpedo is launched by the mine, thus providing a combination of wide acquisition width and high lethality. Mines of all sophistication are developed and manufactured by many countries, most notably (in addition to the U.S.) the United Kingdom, Germany, Italy, Japan, the former Soviet Union (in vast numbers and complexity), and many third world countries. In addition, international weapon sales have resulted, directly or indirectly, in mines being available to just about any country that can afford them...for whatever purpose!

Mine countermeasures, as the name implies, deals with countering or defending against enemy mines. Modern mine countermeasures involves both surface and airborne platforms engaged in mine sweeping and mine hunting. Mine sweeping consists of towing mechanical sweep wires designed to sever moored mine anchor cables or towing influence sweep devices that simulate the magnetic and acoustic signatures of target ships, thus spoofing the mines into detonation sans real target. Mechanical and influence sweep systems are available for both surface mine countermeasures ship tow or airborne mine countermeasures helicopter tow.

Mine hunting consists of locating threat mines using mine hunting sonars deployed either from surface mine countermeasures ships or from mine countermeasures helos. Once identified by sonar, remotely controlled vehicles or explosive ordnance disposal divers neutralize the mines. In either case, sweeping or hunting,

mine countermeasures is a difficult, dangerous, time consuming process that at best gives a warm fuzzy feeling for, but not 100% assurance of, complete mine clearance.

U.S. STRATEGY OVERVIEW FOR THE POST-COLD WAR ERA

An assessment of mine warfare in the post-Cold War era must necessarily begin with a consideration of the overall policy and strategy that the United States will follow in the future. Strategic policy documents such as the President's National Security Strategy [6], the Chairman of the Joint Chiefs of Staff's National Military Strategy [7], and the Secretary of the Navy's white paper entitled "From the Sea" [8] all combine to define defense policy and strategy trends that assure national security while reflecting the massive changes represented by the politics of the evolving post-Cold War era. Clearly, the foundation-rocking effects of the termination of the Cold War and the demise of the Soviet Union are the main drivers of current U.S. national defense strategy.

The central theme among these three key documents is a continuation of a strong deterrence against any strategic nuclear threat, while shifting the defense center of gravity from a global to a regional orientation. Realistically, the probability of a global threat to the U.S. or its allies is essentially eliminated, at least without a warning period measured in years. U.S. national strategists recognize the continued existence of massive military resources within the residual states of the former Soviet Union

(principally Russia), but clearly with the end of the Warsaw Pact, the potential for global war is for all practical purposes nil. Lest we lower our guard, however, the growing third world, regional threat is projected to be very prominent in the years to come.

In general, the national defense strategy is divided into four pillars, namely

- o Strategic Deterrence,
- o Forward Presence,
- o Crisis Response, and
- o Reconstitution.

Focusing on the naval component of our national defense strategy, and keeping these four pillars in mind, U.S. naval strategy and policy contained within "From the Sea" consists of a resized future naval force concentrating on the complex operating environment of the "littoral" or coastlines of the world. "From the Sea" presents a fundamental shift away from open ocean war fighting on (or under) the sea toward operating from the sea (toward the land or in the air) in joint sea-air-land regional operations such as Desert Storm. Navy/Marine Corps operational jointness is particularly emphasized in "From the Sea", further reflecting the shift to regional sea-air-land encounters.

One of the net results of the future defense policy and strategy is that some heretofore top priority naval warfare areas, such as antisubmarine warfare (ASW), have become much less critical in the new environment. On the other hand, with the emphasis on "littoral" or coastal encounters with third world adversaries, one

warfare area in particular has become significantly more prominent, namely sea mine warfare.

MINE WARFARE'S ROLE IN THE POST-COLD WAR ERA STRATEGY

My assessment of mine warfare in the post-Cold War era national defense strategy will be broken down into the two component parts of mine warfare, namely mine countermeasures and mining. Mine countermeasures will be considered first.

Mine Countermeasures. Perhaps more than any other lesson, the lesson of the critical importance of effective sea mine countermeasures was again demonstrated by Desert Shield/Storm. I say again because as Dr. Tamara Moser Melia documented in her timely book "Damn the Torpedoes" A Short History of U.S. Naval Mine Countermeasures 1777-1991 [9], the same mine countermeasures lesson has been demonstrated throughout history since the Civil War, and most recently in the mining of the Red Sea (1984), the 1987/88 Persian Gulf mining, and of course Desert Shield/Storm (1990/91).¹ In most situations, a third-rate naval force placed the ships of the best naval and merchant fleets in the world at severe risk...until completion of mine countermeasures operations.

The basic problem here is that mines are extremely effective weapons that are relatively cheap, are readily available in the international arms market, and are easily deployed by even the most limited maritime resources. The key point I wish to make is that

¹This profound lesson is also presented by Hartmann and Truver in their classic book "Weapons that Wait". (Reference [3]).

with the shift from a global/Soviet threat to a regional/third world threat, the incidence of enemy mining is without question going to be more prevalent in the years to come. As the Navy shifts from operating on the Sea to operating from the sea, enemy mining in shallow water coastal areas, especially in amphibious operating areas, will be particularly troublesome as the damage to Tripoli and Princeton attest. Thus the new operational context will probably see increased enemy use of mines against the U.S. and its allies, mines that will not only potentially greatly affect U.S. and allied naval operations, but will also offer the potential of adversely affecting...or stopping altogether...amphibious operations, the very heart of the Marine Corps!

In short, in addressing mine countermeasures, I am addressing the ability to counter an enemy's power to affect U.S. and allied strategic naval plans through sea mining. The strategic decisions of where a battle should occur and how the overall mix between sea, air, and land forces should be accomplished are clearly at risk and are potentially contingent upon effective mine countermeasures capabilities.

Fortunately, the Navy, due in large part to the Desert Shield/Storm lessons learned, is well aware of this fact. In response, the Navy has restructured its mine countermeasures operational command and has greatly enhanced the mine countermeasures R&D and acquisition program. The mine countermeasures program structure leading into the 21st century is thoroughly explained and justified in the Chief of Naval Operations

Mine Warfare Plan (29 January 1992) [10]. This plan, which has been briefed and approved "up the line" including the Chairman of the Joint Chiefs of Staff, is in place and funded as discussed later under "Industrial Assessment." The plan properly emphasizes shallow water mine countermeasures, especially in conjunction with amphibious operations, and correctly supports developments in the area of remote mine countermeasures (gets the man "out of the loop" for safety and efficiency purposes), and in the areas of continued progress in surface ship and airborne (helicopter) mine countermeasures.

In addition, recent mine countermeasures organizational changes have placed operational control of mine countermeasures under the flag-level position of Commander, Mine Warfare Command (COMINEWARCOM), and have centralized mine warfare acquisition under a flag-level Program Executive Officer (PEO) for Mine Warfare. These significant organizational changes, combined with the mine countermeasures capabilities anticipated through fulfillment of the Mine Warfare Plan, should completely support the strategic pillars of Forward Presence and Crisis Response, providing the tools, operational organization, and expertise to counter any enemy mining attempts in the future.

I turn now to the root cause of all this excitement in mine countermeasures...namely sea mines, the "weapons that wait."²

Mining. As has already been mentioned, mines are cheap,

²Phrasing respectfully borrowed from Dr. Gregory Hartmann in reference [3].

readily available even to the poorest of third world countries, and are relatively easy to deploy. In addition, mines are capable of being very hard to counter and do not actually have to be detonated to be effective. The mere threat of mining, rather actual or perceived, is frequently sufficient to accomplish a mining mission. Historically, the U.S. and its allies have incorporated aggressive mining development, acquisition, and operational programs within their defense structure...but this is no longer the case!

Surprisingly, at a time when most of the recent U.S. naval ship damage from enemy action has been from mines, and at a time when the threat of mining is causing the mine countermeasures program of the U.S. Navy to be significantly increased, the development and use of sea mines almost seems to be completely forgotten. Although included briefly in the Mine Warfare Plan, support for U.S. mine development in the future is virtually zero. The same is true for the mining programs of our allies. If mines are such powerful weapons against us, why then are we not more interested in their use against our enemies? Granted, the Navy does have a reasonable stockpile of modern moored and ground mines, but nothing new is planned, nor is it obvious that even adequate maintenance of what mines we have is planned.

Is this policy on mining right or wrong?

I say it is wrong and I'll explain why below.

I fully realize that the current U.S. sea mining capability was largely driven by the global, Soviet-dominated submarine threat. But I also firmly believe that the strategic pillars of

Forward Presence and Crisis Response, in combination with the shift to regional, coastal scenarios, offer new opportunities for mining, assuming the availability of suitable mines.

Herein lies the problem...the adequacy of our mine stockpile in post-Cold War era littoral operations. Before addressing this issue of stockpile adequacy, however, let's look at how mines could play in tomorrow's naval encounters.

From the strategic point of view, mines in the new operational environment offer the potential of controlling large or small portions of the sea over a large or small period of time...without actual commitment of on-station naval forces. They can force the enemy to fight where we want him to, not where he would prefer to fight. In this regard, mines can blockade or control enemy sea lines of communication in support of economic or political actions without causing loss of life or damage. Thus mines offer tremendous strategic leverage, in actual combat or as a very persuasive bargaining tool. Equally significant, at a time when the Navy is experiencing a draw-down in response to the dissipation of the Soviet Union/Warsaw Pact, mines offer a cost-effective weapon system that is particularly suitable to the shallow waters of the littoral regions of future naval encounters. For example, mines offer the potential of effectively controlling enemy submarine activity in shallow water, by either killing the submarine directly or by forcing it into deep water to be addressed by conventional ASW assets. Mines are therefore a force-multiplying complement to other naval forces.

Hopefully the days when mines were required to control vast areas of open ocean against enemy nuclear submarines, or were required to defend U.S. ports against enemy attack, are gone forever. In place of this outdated global concept of operations, however, the strategic usefulness of mines in the new "littoral" or coastal scenarios should not be underestimated, especially in a severe budget-constrained environment. Our adversaries certainly understand the potential of mining against us, having come close to sinking three of our most modern naval ships recently. I therefore think it is incumbent upon us to equally fully pursue the potential of mining as perhaps an even more effective weapon in our future than it had the potential of being in the Soviet-driven past.

There is one additional aspect of a strong future mining program that is of key importance. I have already shown that the need for effective mine countermeasures is unquestionable and is already strongly supported in the Navy. However, the development of a modern mine countermeasures capability requires a complete understanding of the functions of modern mines...and understanding which can only come from hands-on experience in mine design and actual use. Thus by support of mine development efforts, a very important component of the technology required to counter enemy mines will be established and maintained within the U.S. mine countermeasures data base.

In view of these strong reasons for continued mine development work, I want to emphasize that I fully recognize and appreciate the funding constraints that in part have led to the non-support of

outyear mining programs within the U.S. and among our allies. However, even in a tight defense budget, I recommend, as a minimum, two specific actions to get mining going again to provide the Navy with mining's associated strategic advantages.

First, I recommend establishment of a program to modify existing mines to be optimized for the shallow waters of coastal areas. Such a program would not only tune the U.S. mine inventory to the new "littoral" regional environment, but it would also involve the latest in mine technology, technology that would subsequently be available for mine countermeasures development purposes.

Second, unlike those of most other allied countries who are involved in mine design, the U.S. lead Naval laboratory for mine design is technically distinct from and totally geographically separate from the Naval lead laboratory for mine countermeasures design. Such a situation results in communication barriers and design inefficiencies that reduce the effectiveness of the combined Navy laboratory mine warfare research and development resource. Therefore, in concert with consolidation of mine warfare operations under COMINEWARCOM, consolidation of mine warfare acquisition under a single PEO, and consolidation of defense laboratories in general, I recommend combining U.S. mine and mine countermeasures development under one Navy laboratory at one location to take full advantage of managerial coordination and technical data exchange among the mine and mine countermeasures research and development experts.

In short, history has proven the effectiveness of mines. They aren't glamour weapons by any stretch of the imagination, but they do their job very well! More significantly, mines can become even more effective for the U.S. and our allies in the future...if we provide the opportunity.

A MINE WARFARE INDUSTRIAL ASSESSMENT

I would like to now shift to an assessment of mine warfare industrial concerns vis-a-vis the emerging U.S. strategy and the points made thus far on mine warfare strategic issues.

Mine warfare is a portion, and usually a relatively small portion, of industrial concerns associated with far more than just mine warfare. To illustrate my point, the following listing of companies is representative of domestic concerns involved in mine warfare R&D and/or production during the last decade or so (no mine warfare platform companies included):

- | | |
|--------------------------|--------------------------|
| o Alliant Tech Systems | o Sippican |
| o McDonnell Douglas | o Rockwell International |
| o General Electric | o Hughes |
| o Loral | o Boeing |
| o Aerojet General | o Marquest |
| o Allied Signal (Bendix) | o Kaman |
| o Martin Marietta | o Spartan |
| o ISC Defense Systems | o EDO |
| o Gould Electronics | o Draper Labs |
| o UNISYS | o APL Penn State Univ. |

- o Raytheon
- o Westinghouse
- o ARL Univ of Texas

A similar listing of foreign industrial concerns includes:

- o Marconi (UK)
- o British Aerospace (UK)
- o MISAR (IT)
- o ELSAG (IT)
- o Krupp MAK (GE)
- o Karlskronavarvet (SW)
- o Ferranti (UK)
- o Dowty (UK)
- o CAP/DBE (UK)
- o Thompson Sintra (FR)
- o ECA (FR)
- o Canada Air (CA)
- o ISE (CA)

Two points should immediately come to mind here. First there are many industries involved in one way or another in mine warfare, both domestically and overseas. Second, most of these industries are relatively large, diverse corporations, with mine warfare representing typically a small portion of their overall product lines.

I would like to start my assessment of mine warfare industrial concerns with a qualitative review of some of the strengths of the mine warfare industrial base. The companies listed above represent primarily mine warfare equipment acquisition resources which have produced, are producing, or would like to produce mines or mine countermeasures equipment such as sweeping or hunting systems. Many of the world's largest and most technically advanced defense corporations are represented here and, taken as an aggregate, reflect a potential industrial resource equal to that of any other warfare area. Some of these companies have had a very long term

commitment to mine warfare while some are just now trying to get into the area. Most of the companies have associated political clout spread throughout the United States and Europe and are not shy about using it. Based primarily upon other product lines, these companies possess a massive technology resource and research and development capability poised, under the appropriate circumstances, to be brought to bear upon mine warfare. The government's responsibility in providing these "appropriate circumstances" will be addressed later.

Along with mine warfare industrial strengths, I would like to reflect upon inevitable weaknesses, as well. Due largely to government program fluctuations and historically low funding levels, mine warfare work among these many companies is typically a low priority venture. As a direct result of this relatively low priority for mine warfare, the companies typically invest low levels in independent mine warfare research and development. Clearly the industrial R&D resource is there, it just hasn't been aggressively applied to solving the mine warfare problem.

As an example of another industrial weakness, I do not believe that the potential for international industrial cooperation in mine warfare is even close to being sufficiently tapped. Admittedly government constraints frequently discourage international activity among companies, but there also is considerable corporation policy inertia not directly influenced by the government that discourages international participation, other than on the more mundane vendor level. The term "not invented here" comes to mind in this regard.

Finally, the defense industry in general is going through a period of adjustment to the new circumstances in the absence of the Cold War "driver." The loss of profit opportunity in the face of an overall declining defense acquisition climate during the last several years has resulted in many companies leaving the defense business, and, as a result, investment in development and facilities has decreased considerably. Being more or less broadly represented throughout the overall defense industry, mine warfare industrial concerns are consequently also being affected by this industrial adjustment. Many companies are concerned about the viability of the their major product lines, such as missiles and torpedoes, and simply don't have the time or resources to be concerned about mine warfare issues.

Looking to the future, by far the most significant factor when considering the mine warfare industrial outlook is the big boost that mine warfare has received, and is planned to continue to receive, from Desert Storm mine warfare lessons learned. In macro terms, estimates of the research and development funding and the procurement funding for mine warfare (less ship and helo platform construction and fabrication) are presented below³ (FY,\$M,then yr):

	93	94	95	96	97
R&D	180	220	230	290	380
PROC.	60	100	80	100	100

³These data result from the author's assessment of internal Navy financial planning information accurate as of January, 1993.

R&D above includes funding categories for exploratory development (6.2), advanced technology development (6.3A), advanced development (6.3B), and engineering development (6.4). Procurement above includes all mine and mine countermeasures systems (other procurement, Navy (OPN); weapon procurement, Navy (WPN)) less the actual ship and aircraft platforms. For comparison, the pre-Desert Storm mine warfare R&D program levels were of the order of \$75M to \$100M per year over the same time period (FY93-97). The key point is that the R&D line represents a major increase over the levels associated with mine warfare prior to Desert Storm. The Navy will enjoy, therefore, a three-or four-fold increase in mine warfare research and development funding throughout a period which will see major reductions in other warfare areas!

The industrial message is, therefore, that mine warfare is a growth area in R&D.

Mine warfare is also a potential growth area in procurement, although the figures presented above do not readily indicate this fact. The above mine warfare budget reflects almost exclusively a highly enhanced mine countermeasures program. The R&D line represents the initial stages of many new mine countermeasure system developments which will not come to production phases until after the FY 97 time frame. Consequently, there will potentially be a large positive procurement ramp in the post FY 97 time frame reflecting the results of the large R&D increases in the earlier years. Thus, mine warfare procurement growth should potentially also happen, just not yet. I say "potentially" in this regard

because, as with other Department of Defense development programs, the extent of the effect on mine warfare of the Clinton Administration's policy of putting advanced technology "on the shelf" with deferred production will have to be assessed with time.

In view of this thriving mine warfare budget outlook, the need for increased industrial involvement in mine warfare, without question, clearly exists. I have also shown that the industrial potential clearly exists: the mine warfare industrial players represent the cream of the U.S. and foreign defense industry. As such they bring to the table vast resources in technology and production heretofore applied to other defense areas; but now available to be applied to an expanding mine warfare requirement. The question is how to get industry more involved in mine warfare. The answer involves both government and industrial actions.

Considering industrial actions first, there are several concrete, highly-achievable steps that can be implemented by industry itself to help implement more effective industrial contributions to the growing mine warfare area.

o First, industry must increase corporate commitment to mine warfare. The Navy is serious about a significant and sustained increase in mine warfare support, especially in the mine countermeasures area. This assessment is based on the strong support the Navy's Mine Warfare Plan has received, based on funding data presented above, and based upon the major mine warfare reorganizations in the areas of operations and acquisition that are presently in place.

o Second, industry should more actively interface with all levels of the Department of Defense and Congress. The government needs to know what industry has to offer and industry needs to know what the latest government planning is. The suggested liaison, a two-way street, will help considerably in sustaining the mine warfare enthusiasm that the Navy is now enjoying.

o Third, in addition to more active liaison with government, industry should more effectively coordinate and interface among its own membership. In fact, I believe that industry would be well advised to establish a formal industrial data exchange and coordination organization devoted solely to mine warfare issues. While I realize that mine warfare is already a subset of industrial organizations such as the American Defense Preparedness Association (ADPA), what is intended here is a Mine Warfare Preparedness Association, or some similar organizational structure.

o Fourth, industry needs to significantly increase its international participation in mine warfare activities. Many foreign vendors are used for U.S. mine warfare systems, and occasionally foreign sources are used as subcontractors for U.S. systems, but much more can be done. The foreign industrial resource is as significant, and perhaps even more significant, than that of the U.S. in the mine countermeasures area. Although expanding, the mine warfare budget resource is far from excessive and could be stretched measurably by effective utilization of foreign capabilities with the consequent reduction of duplication

of effort.

o Finally, industry needs to respond to the mine warfare growth area with an aggressive program in independent research and development. Typically, industry performs a very limited amount of mine warfare independent research and development. The reliance to date has been upon government funded R&D for mine warfare acquisition programs...and frankly the mine warfare budget justified little else in the past. Things are changing substantially, however, and I feel that Industry would be very wise to more extensively direct its considerable technology data base toward mine warfare. Mine warfare is not an area that is so sophisticated that technology beyond that already developed for other warfare areas is required. The technology is there! It simply needs to be applied to mine warfare requirements.

Similar recommendations for government action to foster effective mine warfare industrial activity include the following:

o First, and by far the most important, the government must maintain a stable and expanding mine warfare program in the future. This is no small order! The Navy has made a good start, however, and implementation of the recommendations presented in this paper will effectively assist in sustaining support in the long haul.

o Second, the current government emphasis on mine warfare research and development must be continued in the outyears. If mine warfare is to assume the heightened position described in this paper, a strong research and development program in both mine countermeasures and mines must be formulated and fully supported in

the budget. The Navy cannot expect industry to conduct R&D on its own without setting the example with a strong government program. In this regard, government in-house mine warfare R&D must be conducted with the industrial perspective of manufacturing considerations in mind. The transfer of government technology to industry for final engineering and production would be considerably more cost effective with closer integration of production concerns throughout the R&D process.

- o Third, along a similar tack, the government should take the lead in assuring more effective government and industrial mine warfare R&D integration to maximize the total R&D output with minimum duplication of effort.

- o Fourth, the government should assure that one-on-one government-industrial interface is enhanced. Government officials should take the time to cultivate a close relationship with existing and potential mine warfare industrial participants to help achieve mutual understanding and to help maintain enthusiasm. As simple an action as an occasional plant visit by government officials is a very effective means of accomplishing this one-on-one interface.

- o Fifth, the government, even more than industry, should be instrumental in encouraging enhanced international activity. Many of the constraints to international participation in mine warfare are government imposed. The government should aggressively pursue the foreign mine warfare resource through encouragement of international activity through active participation in existing

foreign data exchange organizations and through liberalization of program structure to foster foreign participation.

o Finally, the government should plan and conduct an annual major government-industry mine warfare data exchange conference open to all interested domestic and foreign mine warfare industrial concerns. While such a conference will represent considerable time and some expense on the part of the government, the payoff in program updates to industry and mutual technical data exchange will far exceed any government administrative inputs. Such a conference would go a long way to implementing many of the preceding industry and government recommendations, and would be particularly effective in sending industry the message that the government is serious about mine warfare.

SUMMARY

As U.S. national defense strategy shifts from a global to a regional orientation, sea mine warfare will assume an increasingly important position among those tools available to implement national security policy. The critical role of mine countermeasures in future naval encounters, especially amphibious operations, is fully supported by the Navy, at least at the present time. On the other hand, the role of mining in the new littoral strategies is less obvious, but I believe also of significant importance. Unfortunately, any meaningful future program in the mining area remains to be initiated.

In addition to positive action on the part of the government,

industry is a key partner in establishing mine warfare readiness, and will be even more so as the post-Cold War era evolves and the importance and relative level of funding of mine warfare increases with time.

For purposes of enhancing the implementation of an expanding mine warfare program, several specific recommendations are summarized here:

o **STRATEGIC CONSIDERATIONS**

- oo The Navy should continue strong mine countermeasures support.
- oo The Navy should modify the existing mine stockpile to optimize for shallow water, littoral scenarios.
- oo The Navy should consolidate mine and mine countermeasure development at one Navy laboratory location.

o **INDUSTRIAL CONSIDERATIONS**

- oo Industry should...
 - increase corporate commitment to mine warfare,
 - increase mine warfare liaison with the government,
 - increase intra-industrial mine warfare liaison,
 - increase international mine warfare cooperation, and should
 - increase industrial-supported mine warfare R&D.
- oo The government should...
 - maintain a stable mine warfare program for industrial participation,

- support a strong government mine warfare R&D program tuned to industrial concerns,
- encourage more effective government-industrial R&D cooperation,
- strive to more effectively communicate/coordinate with industry in all areas,
- encourage international industrial mine warfare activity, and should
- conduct an annual government-industry (both domestic and foreign) mine warfare data exchange conference.

In conclusion, mine warfare is poised to take its place as a major strategic player in the defense of the United States and its allies. Mine countermeasures is well on its way, but mining needs much encouragement. The recommendations that I offer are basically qualitative thrusts that if accepted whole, or at least in part, will certainly assist in establishing and maintaining mine warfare's position in the defense big leagues.

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